is known) may account for the peculiar curve. The second explanation is that the magnesium ion, the sulph-ion and the undissociated $MgSO_4$, the proportions of which change with the concentration, have altogether different effects upon the solubility of gypsum.

On Monday afternoon the society visited Audubon Park and the sugar experiment station, where opportunity was given to witness all the processes of sugar-making, from the growing cane to finished sugar.

On Tuesday morning a special train was chartered on the Louisiana Southern Railroad to take the party to the Braithwaite Sugar Factory where about one thousand tons of cane are worked up per week. In the afternoon a sugar refinery and the National Rice Mills were visited.

Chas. L. Parsons,
Secretary of Section C,
C. E. Waters,
Press Secretary.

SCIENTIFIC BOOKS.

The Organization and Cell-lineage of the Ascidian Egg. By Professor E. G. Conklin, Journal of the Academy of Natural Sciences of Philadelphia, Second Series, Volume XIII., Part I., 1905.

The work on cell-lineage which produced so large a number of papers a few years ago has very naturally led to the study of the visible organization or differentiation of the egg, not only during cleavage, but in earlier stages. The search for cell homologies has given place in large measure to the search for 'formative substances,' 'morphogenic substances' or 'morphoplasmic substances' as the visible differentiations of the egg have been variously called. And since it is true in biology as elsewhere—perhaps more so—that 'they that seek shall find,' our knowledge of the visible differentiations of the egg-substance is rapidly increasing.

The paper under review constitutes an important contribution to this subject. It is an exceedingly careful study, based primarily upon the egg of *Cynthia* (*Styela*) *partita* Stimpson, with comparative observations on the eggs of *Ciona intestinalis* (L.) Flemming and *Molgula manhattensis* Verrill.

The titles of the seven sections, which with the introduction compose the paper, indicate its scope: I., 'The Ovarian Egg'; II., 'Maturation and Fertilization'; III., 'Orientation of Egg and Embryo'; IV., 'Cell-Lineage'; V., 'Later Development'; VI., 'Comparisons with Amphioxus and Amphibia'; VII., 'The Organization of the Egg.'

The most important cytological observations concern the character of the spindles in maturation and the first two cleavages. The maturation spindles are without centrosomes and are formed wholly within the nuclear area: at first their fibers radiate in all directions, but finally form a barrel-shaped spindle. Influence of centrosomes and traction of spindle fibers are not concerned in the separation of the chromosomes in the maturation divisions. In the first cleavages a small nuclear spindle similar to the maturation spindles lies between two large asters.

The spermatozoon enters near the lower pole and rotates after entering. The centrosome is derived from the middle piece and gives rise to the cleavage centrosomes. As regards orientation of the ascidian egg much difference of opinion has existed. Conklin reviews the various systems of orientation, viz., those of Van Beneden and Julin, Seeliger, Samassa and Castle, and gives what appears to be convincing evidence in favor of the first mentioned. According to this the first cleavage plane corresponds with the median plane, the spindle being eccentric toward the posterior pole. The second cleavage is transverse. The intersection of these two planes corresponds with the dorso-ventral axis of the gastrula and the third cleavage separates dorsal from ventral cells.

The account of cell-lineage is complete to a stage consisting of 218 cells. Gastrulation begins at about the 112-cell stage. Development is remarkably rapid, *Cynthia* and *Ciona* attaining the tadpole stage in twelve hours after fertilization and *Molgula* in eight hours.

Extensive cytoplasmic movements during the earlier cleavages are described.

Conklin differs from Castle in maintaining that the nervous and muscular systems do not arise from a common primordium and that there is no nerve ring around the blastopore.

Comparison of the early development of ascidians, *Amphioxus* and amphibians shows agreement, according to Conklin, as regards axial relations of egg and larva, bilaterality of cleavage, method of blastopore-closure, and probably also as regards origin and position of neural plate chorda and mesoderm.

But the paper is primarily concerned with egg organization. Hypotheses of formative substances and organization are receiving much attention at present, but have been subjected to but little analysis and criticism. It has seemed desirable, therefore, although the writer does not over-value destructive criticism, to attempt in connection with this review a brief critical examination of some of the more important conclusions set forth in this paper.

The earliest indication of polarity consists in the location of the yolk matrix on one side of the nucleus and a slight eccentricity of the latter toward the animal pole.

Since the yolk matrix is derived, according to the author, from the sphere of the last oogonic division and supposedly contains the centrosome, he is inclined to identify the polar axis of the egg with the cell axis in general and suggests that polarity may thus be handed down from one generation to another.

In the living eggs of *Cynthia, Ciona* and *Molgula,* when first laid, three regions are distinguishable, a peripheral layer of clear protoplasm in which the test cells lay in earlier stages and which in *Cynthia* contains sparse yellow granules, the central mass of yolk and the large germinal vesicle. When the nuclear membrane disappears at the beginning of maturation a large amount of clear protoplasm passes into the cell-body and forms a mass eccentric toward the animal pole and distinct from the yolk and peripheral layer.

The spermatozoon enters on the lower hemisphere, apparently at any point within 30° of the vegetal pole. After entrance rotation occurs and the aster precedes in later movements.

Immediately after the entrance of the spermatozoon the yellow and clear protoplasm flow rapidly to the lower pole where the yellow protoplasm collects around the point of entrance; the clear protoplasm lies at a deeper level. The yellow protoplasm then spreads out until it covers the surface of the lower hemisphere.

The withdrawal of protoplasm from the upper pole leaves the maturation spindles closely surrounded by yolk. The polar bodies are thus formed at the middle of a yolk-rich hemisphere, which is, however, the animal pole and not the vegetal pole as was claimed by Castle.

Castle's conclusion that the polar bodies are formed at the vegetal pole of the ascidian egg has stood since its appearance in disagreement with our knowledge of most other eggs. Conklin's observation of the movement of the chief protoplasmic portions of the egg toward the vegetal pole is important in that it clears up this error.

The sperm nucleus moves from the point of entrance toward the equator in a path which is apparently predetermined. This path lies in the plane of the first cleavage and the point, just below the equator at which the sperm nucleus stops in its upward movement, becomes the posterior pole of the embryo. All the axes of the future animal are now clearly established, antero-posterior, right-left, dorso-ventral.

Conklin's statements regarding the path of the spermatozoon appear to the writer to be in serious conflict. If the spermatozoon enters at any meridian of the egg and moves from its point of entrance along a path which corresponds with the plane of the first cleavage, as Conklin states, the only possible conclusion would seem to be that the point of entrance determines the plane of the first cleavage. Yet Conklin regards this path as predetermined. The only evidence offered in support of this view is that the spermatozoon apparently does not always take the shortest path to the equatorial region, but sometimes crosses the egg axis on its way. This conclusion in turn is based on the study of sections. If the copulation path of the sperm is predetermined penetration must be followed by movement into the predetermined meridian

in all cases except where the point of entrance happens to lie in this meridian. No evidence for such movement is given; indeed, it is by no means demonstrated that the spermatozoon always moves in a meridian of the egg. The movements of the spermatozoon constitute the only indications that bilateral organization exists before fertilization and they seem to the writer to oppose rather than to support the conclusions drawn from them.

As the sperm nucleus moves to the posterior pole the clear and the yellow protoplasm move with it; the latter collects into a yellow crescent with its middle at the posterior pole and its horns extending about half way around the egg just below the equator. This position it retains throughout the whole development, giving rise to the muscle and mesenchyme cells.

After the sperm and egg nuclei have met at the posterior pole they move in toward the center of the egg and the clear protoplasm goes with them; the only place where the latter remains in contact with the surface is along the upper border of the crescent. At the close of the first cleavage the nuclei and clear protoplasm move into the upper hemisphere, and thereafter, throughout development, this hemisphere contains most of the clear protoplasm and gives rise to the ectoderm.

The yolk which before maturation was central in position is shifted toward the animal pole when the protoplasm flows down to meet the spermatozoon; when the sperm nucleus and surrounding protoplasm move to the posterior pole the yolk is moved down around the anterior side of the egg to the lower pole, and when the clear protoplasm moves into the upper hemisphere of the yolk is largely collected in the lower hemisphere. This yolk-rich area gives rise to the endoderm.

At the end of the first cleavage the chorda and neural plate areas are visibly different from surrounding regions, since they contain less yolk. Later muscle and mesenchyme become distinguishable, the former being deep yellow, the latter light yellow or clear.

These are the most important facts regarding the 'organ-forming substances.'

Before turning to Conklin's general conclusions a brief consideration of the grounds for believing that the differentiated regions represent formative substances is necessary. And first, what are the formative substances? The visible differentiations of the egg are due not to visible differences in the protoplasm itself, but to the localization of the inert substances, yolk and the yellow granules. Conklin does not regard these inert substances as formative, but apparently believes their localization indicates a corresponding localization of different 'kinds of protoplasm.' We are justified in inferring from the presence of different inert substances that different kinds of activity have occurred in the past, but certainly a single 'kind' of so complex a substance as protoplasm is capable of various activities under different conditions. Moreover, the significance of inert substances in protoplasm is primarily retrospective, not prospective.

The protoplasm containing yellow granules in the *Cynthia* egg gives rise to muscle and mesenchyme, according to Conklin. Yet the yellow granules are not confined to this region, but appear about all the nuclei during cleavage, about the nuclei of the test cells, and in the viscera of the adult. In other words, there is no indication that this region contains any specific kind of protoplasm not found elsewhere. During ovarian stages the test cells invade the peripheral layer of the egg. It seems at least not improbable that the yellow granules are associated with the earlier presence of the test cells.

The yolk spherules are similarly inert; their localization in the egg can be as readily explained on physical grounds as by postulating a specific kind of protoplasm in the region where they exist. It is quite probable that the presence of yolk granules determines special activities in the protoplasm about them, and indeed it is not unlikely that the yolk itself is the important entodermal formative substance. But that there is no special formative substance corresponding to the yolk region is indicated by the fact that parts of it go to other than entodermal regions.

The fact that the clear protoplasm from the nucleus and the yellow protoplasm move downward to meet the sperm and accompany it in its movements does not necessarily indicate anything more than greater mobility of these areas in consequence of the absence of yolk. In certain other eggs, where no such areas

exist, the protoplasm from between the yolk spherules gathers about the spermatozoon. There is, moreover, no certainty that the same protoplasm remains continuously in a given region. The regions persist, but in view of the observations on ectosarcal activities in eggs and the extensive flowings of cytoplasm to which Conklin himself has devoted so much attention, it seems very probable that there is extensive physical interchange of protoplasm between various parts of the egg. For example: is there any certainty that the area of clear protoplasm escaping from the nucleus at maturation and later giving rise to ectoderm really consists throughout of the same protoplasm? There is no visible boundary between it and other portions of the cytoplasm. In short, how can we identify the actual formative substances, if such exist, and how can we be certain that they do exist? Caution is certainly necessary along this line; observation alone does not afford a sufficient basis.

The final section of the paper is devoted to a general discussion of the problem of egg organization and its genesis. The first part of the section is largely a résumé of our knowledge and opinions regarding polarity, symmetry and localization and only certain points need be considered.

In the opening sentences of the section the following statement occurs:

For our present purposes the organization of the germ cells * * * may be held to include phenomena of polarity, symmetry and localization; it obviously includes other things also, such as regeneration and regulation, which are not, however, objects of investigation in this work.

In the discussion of localization the position is taken that experiments with egg fragments are no test of the presence or absence of differentiation and the ascidian egg is cited as a case in point; here the cleavage is determinate, the differentiations of the various parts of the unsegmented egg are very great, yet experiments have apparently demonstrated the totipotence of the first four blastomeres. From consideration of these facts Conklin is led to the following conclusion:

Just as some adult forms show little capacity for regeneration or regulation while others of equally complex differentiation show this power in high degree, so it seems that the capacity for regulation shown by eggs is more or less independent of their differentiation.

Incidentally it would be interesting to know on what facts the first half of this statement—that regarding adults—is based. To the writer there seems to be no escape from the conclusion that an isolated blastomere capable of producing a whole embryo is in some way more like the whole egg than another without such power. Moreover, it was admitted in the sentence quoted a few lines above that egg organization must include the phenomena of regulation. Even if we follow Conklin and adopt Roux's view of two different methods of development, direct and indirect, the organization must provide for each. There is something very like a dilemma here.

This is an excellent example of the difficulties involved in maintaining the position that the visible cytoplasmic differentiations are formative in character. How far that is the case observation alone can never determine. Conklin says 'all the experiments in the world could not have shown as satisfactorily as direct observation has done the remarkable cytoplasmic differentiations and localizations of this egg'—viz., the ascidian. But it is equally true that all the observation in the world could not have shown as satisfactorily as experiment has done—and we may add, will do—how far these cytoplasmic differentiations and localizations are from representing the actual formative powers of the egg.

As regards the genesis of egg organization, Conklin believes that the differentiations of eggs, blastomeres and possibly other cells also are the result of two processes, the genesis of unlike substances and their localization. The escape of nuclear material into the cell body, and the formation there of specific substances and their localization are regarded as affording a specific mechanism for nuclear control of development 'and as harmonizing the facts of cytoplasmic organization with the nuclear inheritance theory.' As a case in point, the distribution of the sphere material from the last oogonic division is cited. Conklin holds that a part of this material forms the yolk

matrix and a part passes into the peripheral layer. If the sphere material is derived from the nucleus as is the case in Gasteropods, according to Conklin, then both the mesoplasm and entoplasm receive substances derived from the nucleus at the preceding division. Again, the clear protoplasm (ectoplasm, Conklin) escapes from the nucleus at the first maturation division.

The various substances arise epigenetically even in the nucleus, but 'all the evidence favors the view that back of the organization of the cytoplasm is the organization of the chromosomes which is definite, determinate and primary.' Thus from visible formative substances we pass to invisible, hypothetical substances and end not far removed from Weismann in the organization of the chromosome.

The term 'organization' is much employed of late, apparently as an explanation. But organization alone is the dynamo without electricity. The important question regarding all hypothetical organization in biology is, will it work? It would seem that at least some suggestion as to how it may work should be offered. How and why, for example, do the formative substances form what they are assumed to form? How and why does the nucleus give rise to ectodermal substance at one time and to mesodermal substance at another? If we have truly abjured vitalism organization must be reducible to terms of physics and chemistry. Why should we not make the attempt to reduce it instead of clinging to the vague term. If it is not so reducible then organization is a vitalistic concept. To the writer it seems at least a question whether a 'definite, determinate and primary' organization of the chromosomes is reducible to terms of physics and chemistry.

Four types of germinal localization are distinguished by Conklin: the annelid-mollusk, the ctenophore, the echinoderm and the ascidian. Among these there is no convergence in passing from later to earlier stages. Precocious segregation is rejected as an explanation of egg organization. This organization, like adult structure, must in the final analysis depend upon the chromosomes in the germ cells. The structure of later stages is the result, not the cause of the structure of the germ cell. Extensive modifications of adult structure may therefore be brought about by slight changes in germinal organization.

In conclusion, one or two minor matters should, perhaps, be mentioned. The author uses the words 'ovocyte' and 'ovogonic,' but also the word oöplasm. The first two are examples of those mongrel words with which biology has been frequently afflicted; the last is a word of good parentage.

Addition of the plate numbers to the references to figures would certainly facilitate the finding of particular figures.

C. M. Child.

Lehrbuch der Meteorologie. Von Dr. Julius Hann. Second edition. 8vo. Leipzig, 1906. Pp. xi + 642.

What Hann's 'Handbuch der Klimatologie,' in its first and second editions, is to climatology, the same author's 'Lehrbuch der Meteorologie,' in its first and second editions, is to meteorology—a comprehensive, well-digested, thoroughly authoritative text-book; absolutely indispensable to every worker in this science, and to every one else who seeks information on any special point in meteorology and who wishes to go to headquarters for an answer to his question. The first edition of the 'Lehrbuch' appeared in 1901 (see review in Science, Vol. XIV., N. S., December 20, 1901, pp. 966–967), and although but four years have elapsed since then, a second edition is now before us, with all the latest advances of the intervening period set fully and clearly before the reader. What we said in our notice of the first edition can be repeated, with added emphasis, of the second. Everything is brought down to date. For example, in the earlier edition it was stated that the results of the international cloud year were incomplete, but would probably give a fairly conclusive answer to questions regarding cloud heights and velocities. On p. 208 of the new edition it is stated concerning these results that they *have given* an answer to almost all questions as to cloud heights and velocities. This is typical of the treatment